

The figure illustrates the relationship between orbital filling and the periodic table. The main diagram shows the periodic table with blocks for s, f, d, and p sublevels. The inset shows the order of sublevel filling: 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, 7p.

Figure 8.6 The relation between orbital filling and the periodic table. If we “read” the periods like the words on a page, the elements are arranged into sublevel blocks that occur in the order of increasing

energy. This form of the periodic table shows the sublevel blocks. (The *f* blocks fit between the first and second elements of the *d* blocks in Periods 6 and 7.) *Inset*: A simple version of sublevel order.

Group and Period Numbers Key information is embedded in the periodic table:

1. Among the main-group elements (A groups), *the group number equals the number of outer electrons* (those with the highest n): chlorine (Cl; Group 7A) has 7 outer electrons, tellurium (Te; Group 6A) has 6, and so forth.
2. *The period number is the n value of the highest energy level.* Thus, in Period 2, the $n = 2$ level has the highest energy; in Period 5, it is the $n = 5$ level.
3. The n value squared (n^2) gives the total number of *orbitals* in that energy level. Because an orbital can hold no more than two electrons (exclusion principle), $2n^2$ gives the maximum number of *electrons* (or elements) in the energy level. For example, for the $n = 3$ level, the number of orbitals is $n^2 = 9$: one $3s$, three $3p$, and five $3d$. The number of electrons is $2n^2$, or 18: two $3s$ and six $3p$ electrons occur in the eight elements of Period 3, and ten $3d$ electrons are added in the ten transition elements of Period 4.

Unusual Configurations: Transition and Inner Transition Elements

Periods 4, 5, 6, and 7 incorporate the *d*-block transition elements. The general pattern, as you’ve seen, is that the $(n - 1)d$ orbitals are filled between the ns and np orbitals. Thus, Period 5 follows the same general pattern as Period 4. In Period 6, the $6s$ sublevel is filled in cesium (Cs) and barium (Ba), and then lanthanum (La; $Z = 57$), the first member of the $5d$ transition series, occurs. At this point, the first series of **inner transition elements**, those in which *f* orbitals are being filled, intervenes (Figure 8.6). The *f* orbitals have $l = 3$, so the possible m_l values are $-3, -2, -1, 0, +1, +2$, and $+3$; that is, there are seven *f* orbitals, for a total of 14 elements in *each* of the two inner transition series.

The Period 6 inner transition series fills the $4f$ orbitals and consists of the **lanthanides** (or *rare earths*), so called because they occur after and are similar to lanthanum. The other inner transition series holds the **actinides**, which fill the $5f$ orbitals that appear in Period 7 after actinium (Ac; $Z = 89$). In both series, the $(n - 2)f$ orbitals are filled, after which filling of the $(n - 1)d$ orbitals proceeds. Period 6 ends with the filling of the $6p$ orbitals as in other *p*-block elements. Period 7 is incomplete because only two elements with $7p$ electrons have been confirmed at this time.

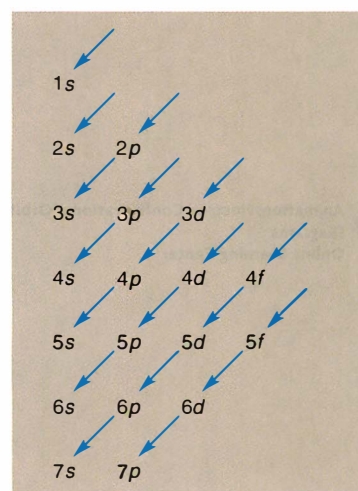


Figure 8.7 Aid to memorizing sublevel filling order. List the sublevels as shown, and read from 1s, following the direction of the arrows. Note that the

- n value is constant horizontally
- l value is constant vertically
- $n + l$ sum is constant diagonally.